

Application Note

SmartScan50

Volume and Custom Flume Configuration

Version 1.1

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1. SCOPE

This document describes the configuration procedure of SmartScan50 unit for volume measurement and for flow measurement in custom flumes. The document should be read jointly with the user manual of SmartScan systems.

2. OBJECTIVES

Familiarize the user of SmartScan50 with:

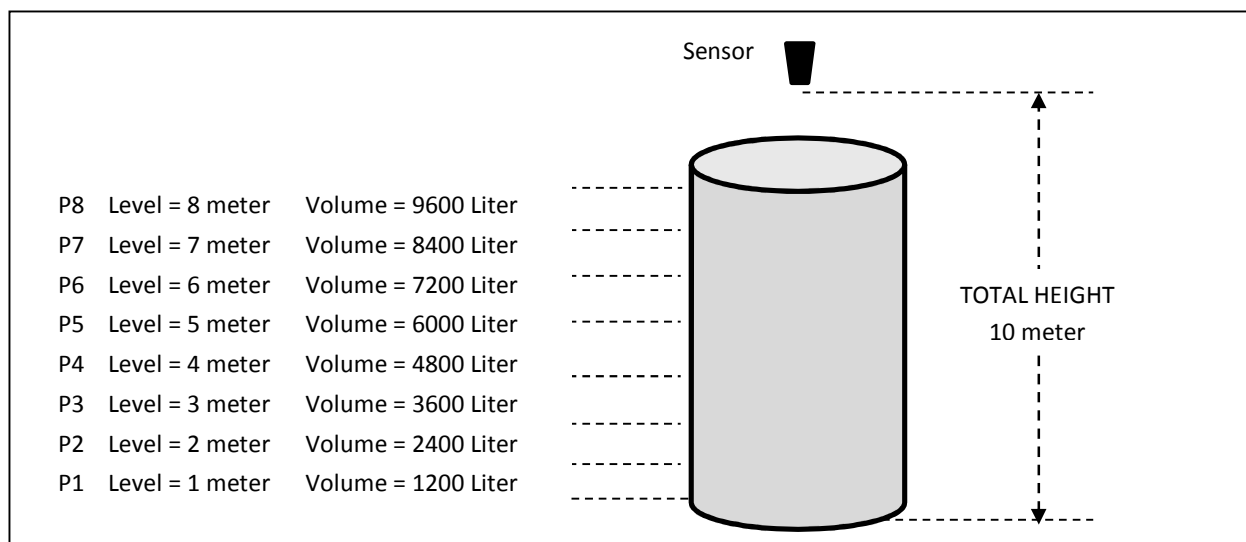
- Configuration methods for making volume and flow measurements.
- Configuring volume measurements using manual insertion of strapping tables.
- Configuring volume measurements using semi-automatic insertion of strapping tables.
- Setting 4-20mA configurations for volume and for custom flow measurements.
- Weight calculations using the "K factor".

3. METHOD FOR MEASURING VOLUME

Ultrasonic level sensors measure DISTANCE between the sensor and surface of the target. If distance between sensor and bottom of tank is known (TOTAL HEIGHT), SmartScan50 can also calculate LEVEL.

For VOLUME, the user should configure SmartScan50 to map between LEVEL and VOLUME.

SmartScan50 provides for a mapping table (also known as strapping table) of up to 24 points. The user enters a minimum of 8 points and for each point the user defines LEVEL and corresponding VOLUME. The drawing below illustrates the insertion of LEVEL points into the strapping table:



The strapping table is set by entering point by point from the low level and up. Each point involves three main steps and step 3 consists of two entries:

Step	Description	Example	Explanation
1	Point number	4	Point number 4
2	LEVEL measured from bottom of tank	004.000	Level is 4 meters
3	VOLUME for this LEVEL	4800.5	Desired volume is 4800.5 Liters
3.1	Truncated part of the VOLUME	004800	Truncated part is 4800
3.2	Decimal part of the VOLUME	800.500	Entry includes 3 rightmost digits from the truncated part.

Note that in step 3.2, the user re-enters the three rightmost digits which have been entered in step 3.1 and one additional digit to the right of the decimal point. The strapping table that corresponds to the drawing is now:

Point	Level	Volume step 1	Volume step 2
1	001.000	001200	200.000
2	002.000	002400	400.000
3	003.000	003600	600.000
4	004.000	004800	800.000
5	005.000	006000	000.000
6	006.000	007200	200.000
7	007.000	008400	400.000
8	008.000	009600	600.000

Important notes:

1. Values are entered as LEVEL not DISTANCE.
2. First point indicates bottom of the vessel with minimum volume. As you add more points to the strapping table, the level increases corresponding to increasing volume.
3. No need to add a point with a LEVEL zero to represent the bottom of vessel with zero volume.
4. It is forbidden enter any zero value of volume, the first volume value should be greater than zero.
5. It is forbidden to enter a level value which is greater than TOTAL HEIGHT.
6. The thickness of the "slices" does not need to be equal. On the contrary, for different vessel shapes it is reasonable to define thinner slices where the volume does not increase linearly.
7. Minimum of 8 strapping points is required.

Setting SmartScan50 to VOLUME measurement:

From the main configuration menu set the following parameters:

- Type of application – Set to Level.
- Units – Set your own units (i.e. meter, inch, feet, etc.).
- Tank height – Set vessel height bottom to sensor.

Do not define the 4-20mA current values yet.

From the “additional configuration” menu set the following parameters:

- Pr.0 – Set Ind1 for volume measurement.
- Pr.1 or Pr.2 – Define strapping table.

With SmartScan it is possible to define the strapping table in two methods:

- Manual insertion of strapping table: The user enters both LEVEL and VOLUME values.
- Semi-automatic insertion of strapping table: SmartScan measures LEVEL and the user only enters the corresponding VOLUME value.

Loop current values 4-20mA are set after strapping table is configured. SmartScan50 is ready for volume measurement after exiting the configuration menu.

Important notes: It is recommended to map vessel interferences using Scan Distance option. Refer to the User Manual of SmartScan for details.

4. MANUAL INSERTION OF STRAPPING TABLE

Use “manual insertion of strapping table” when:

- There is a fixed known ratio between LEVEL and VOLUME for your vessel.
- The vessel is of standard shape such as cylinder or cone or and it is easy to map LEVEL to VOLUME. Refer to appendix A for some examples.
- It is not possible to use the semi-automatic mode.

Manual insertion of strapping table is performed with the additional menu configuration - Pr.1.

When entering Pr.1, SmartScan50 will prompt with the first point, P1. For each point the user should define the required LEVEL and corresponding VOLUME.

For example, for the vessel discussed above:

P1 <Ent> Level: Volume, first screen: Volume, second screen:	001.000 <Ent> 001200 <Ent> 200.000 <Ent>
P2 <Ent> Level: Volume, first screen: Volume, second screen:	002.000 <Ent> 002400 <Ent> 400.000 <Ent>
P3 <Ent> Level: Volume, first screen: Volume, second screen:	003.000 <Ent> 003600 <Ent> 600.000 <Ent>
...	
P8 <Ent> Level: Volume, first screen: Volume, second screen:	008.000 <Ent> 009600 <Ent> 600.000 <Esc>

Pressing <Esc> after the eighth point, indicates that this point is the last of the table.

5. SEMI-AUTOMATIC INSERTION OF THE STRAPPING TABLE

Use "semi-automatic insertion of strapping table" when:

- The ratio between LEVEL and VOLUME for your vessel is not known.
- The vessel is of unique shape and it is complicated or impossible to map between LEVEL and VOLUME.

Semi-automatic insertion of strapping table involves a calibration phase using a controlled filling process and should be performed after interferences were identified and mapped using the “Scan Distance” technique.

The procedure for semi-automatic insertion of mapping table is as follows:

1. Start with an almost empty vessel or at the first point where the contained volume is known.
2. In semi-automatic mode, the level is measured and calculated automatically by SmartScan50. Accept the display level by pressing <Ent>.

The level measurement may be incorrect. If so, press <Next> to search for a next level target.

3. Enter the volume value for this level.
4. Fill the tank with known volume value. As a result the level of the material within the vessel will be increased.
5. For a new point, the unit will calculate the new level.
6. For the new point enter the new volume value.
7. Repeat steps 4 through 6 until the last point is entered.

This method provides more accurate volume calculations when compared with the manual method, but entails slower calibration due to the need for filling the vessel with known quantity per each point.

This method is activated from Pr.2 of the “Additional menu”.

Important note: It is recommended that strapping table points will not overlap scan distance points. Keep a gap of at least 40 cm between the nearest strapping table point and interference. For example: if there is an interfering echo at 2meter level, use “semi-automatic” level points at 1.6 meter and/or 2.4 meter.

For example, for the same vessel discussed above, the process is as following:

P1 <Ent> Level: Volume, first screen: Volume, second screen:	Searching 001.000 <Ent> 001200 <Ent> 200.000 <Ent>
P2 <Ent> Level: Volume, first screen: Volume, second screen:	Searching 002.000 <Ent> 002400 <Ent> 400.000 <Ent>
P3 <Ent> Level: Volume, first screen: Volume, second screen:	Searching 003.000 <Ent> 003600 <Ent> 600.000 <Ent>
...	
P8 <Ent> Level: Volume, first screen: Volume, second screen:	Searching 008.000 <Ent> 009600 <Ent> 600.000 <Esc>

Pressing <Esc> after the eighth point indicates that point eight is the last point in the strapping table.

6. LOOP-CURRENT CONFIGURATION FOR VOLUME

Once the user configures SmartScan50 to volume and sets the strapping table points, it is possible to configure 4mA and 20mA parameters to represent volume values.

The default value of volume is set automatically based on the strapping table. The 4mA indication will be set to the first point (minimum value) and the 20mA indication will be set to the last point (maximum value).

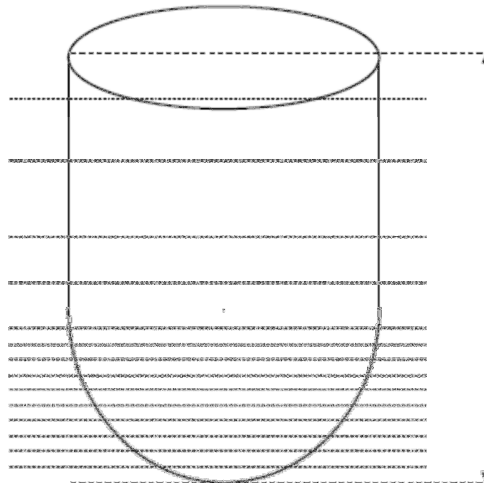
For example, based on the strapping table of the previous examples, 4mA and 20mA will automatically be configured as follows:

- 4mA – 001200
- 20mA – 009600

7. CONFIGURING SPECIAL VESSEL SHAPES

For vessels which are of odd shapes, VOLUME is not always linear related with LEVEL. The user should define the “slices” of the strapping tables unevenly and include at least one point for each irregular mapping.

An example of such “slicing” is illustrated in the next figure.



In this drawing, one can see that a fixed deviation in LEVEL at the vessel bottom, will map to unequal VOLUME deviations. At higher levels of the vessel the ratio between level and volume is fixed.

In this case, it is better to define more “slices” at the bottom of the vessel. The same guidelines as defined in previous sections apply to this case as well.

Important note: It is recommended to use all 24 strapping table points for better accuracy.

8. WEIGHT CALCULATIONS

In some applications the user would like to have the WEIGHT value of the vessel content instead of VOLUME. Weight can be calculated if both VOLUME and specific gravity density of the material are known.

Let the measured volume be “Y” and the material gravity density be ‘K’, then the weight “X” can be calculated as follows:

Weight = Specific Gravity Density * Volume

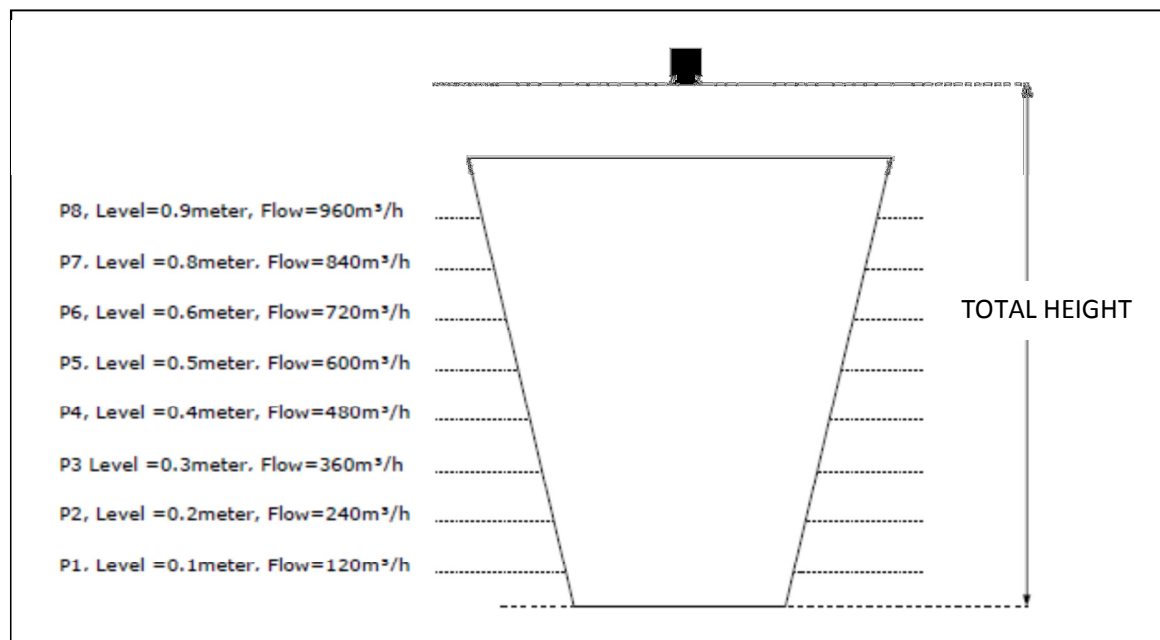
X = K * Y

The “K Factor” is defined Pr.3 of the “additional menu”. The default value of “K Factor” is 001.000.

9. FLOW MEASUREMENT OF CUSTOM FLUME

When custom flume measurements are required, the user should configure SmartScan50 to map between FLOW and corresponding LEVEL.

SmartScan50 provides for a 24 point mapping table (also known as strapping table). For each point the user should define the level and the corresponding flow for this level. The drawing below illustrates the LEVEL to FLOW mapping.



The strapping table is set as follows:

Step	Description	Example	Explanation
1	Point number	4	Point number 4
2	LEVEL measured from bottom of flume	000.400	Level is 0.4 meters
3	FLOW for this LEVEL	4800.5	Desired volume is 4800.5 Liters
3.1	Truncated part of FLOW	000480	Truncated part is 480
3.2	Decimal part of FLOW	480.000	Entry includes 3 rightmost digits from the truncated part.

Note that the last three digits entered in the previous step, are displayed before the decimal point and that the user can enter one digit after the decimal point. The strapping table that corresponds to the above drawing is as follow:

Point	Level	Flow first step	Flow second step
1	0.1 meter	000120	120.000
2	0.2 meter	000240	240.000
3	0.3 meter	000360	360.000
4	0.4 meter	000480	480.000
5	0.5 meter	000600	600.000
6	0.6 meter	000720	720.000
7	0.7 meter	000840	840.000
8	0.8 meter	000960	960.000

Important notes:

1. Values entered are in LEVEL for, not DISTANCE.
2. First point indicates bottom of the flume and minimum flow (it should be the first point value and not zero level which indicates empty flume). As you add more points to the strapping table, the level increases and so is the flow.
3. The first point can be any value greater than zero.
4. Thickness of strapping table "slices" does not need to be even. For varying flume shapes it is reasonable to define thinner slices where the flow does not increase linearly.
5. A minimum of 8 strapping points is required.
6. No LEVEL value should be greater than TOTAL HEIGHT.

Setting SmartScan50 for custom flume measurements:

From the main configuration menu set the following parameters:

- Type of application – set to Flow.
- Units – choose your own units (i.e. M3/h, GPM).
- Tank height – set to distance from sensor face to bottom of flume

Do not define 4-20mA current values yet.

From the “Main menu” set the following parameters:

- PARSH.FLUM
 - For custom flume use 0.E01 (for additional information please check SmartScan User Manual)
- After defining a strapping table in one of the methods mentioned above, set 4mA and 20mA values as described in the user manual.

The device is ready for custom flume measurement after exit from the configuration menu.

10. LOOP-CURRENT CONFIGURATION FOR CUSTOM FLUMES

Once the user configures the SmartScan50 to custom flume and sets the strapping table points, it is possible to configure 4mA and 20mA parameters for FLOW values.

The value of FLOW should be entered manually according to the strapping table. The 4mA indication should be configured at the first point (minimum value) and the 20mA indication should be configured at the last point (maximum value).

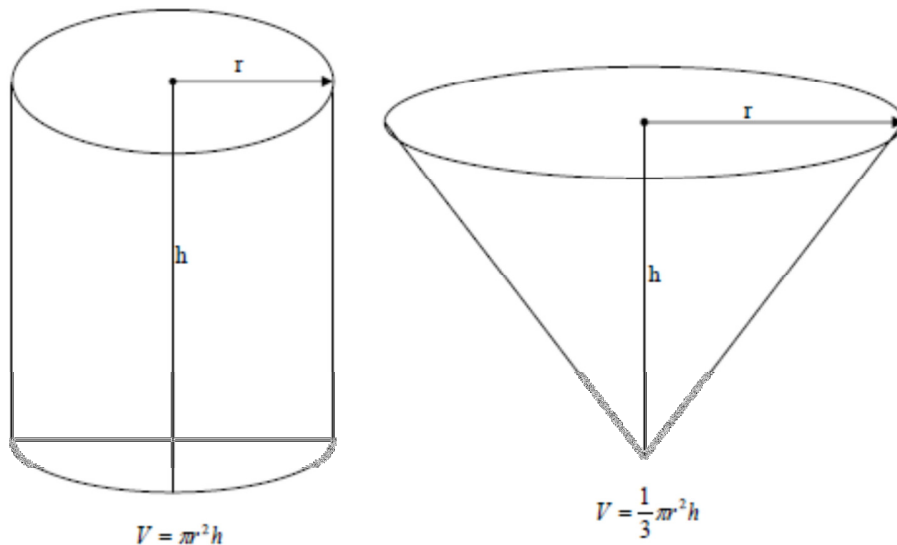
For example base on the strapping table in the table above, 4mA and 20mA should be configured as following:

- 4mA – 000120
- 20mA – 000960

Important notes: 20mA default value is 55490.

APPENDIX A: VOLUME CALCULATIONS

When the vessel has a cylindrical or conical standard shape, it is easy to calculate the volume of the vessel with mathematical volume equations. The following figure illustrates cylindrical and conical vessel volume calculations.



Using the equations, it is easy to calculate the height-to-volume mapping. For example, assume a cylinder shaped vessel with 2-meter radius and 8 meter height. The following table defines the height-to-volume mapping:

Height	Volume
1meter	$V = \pi r^2 h = \pi 2^2 1 = 12.57$
2meter	$V = \pi r^2 h = \pi 2^2 2 = 25.13$
3meter	$V = \pi r^2 h = \pi 2^2 3 = 37.70$
4meter	$V = \pi r^2 h = \pi 2^2 4 = 50.27$
5meter	$V = \pi r^2 h = \pi 2^2 5 = 62.83$
6meter	$V = \pi r^2 h = \pi 2^2 6 = 75.40$
7meter	$V = \pi r^2 h = \pi 2^2 7 = 87.96$
8meter	$V = \pi r^2 h = \pi 2^2 8 = 100.53$